DESCRIPTION

ALUMINUM ALLOY FOR CUTTING PROCESSING, AND ALUMINUM ALLOY WORKED ARTICLE MADE OF THE SAME

Priority is claimed to Japanese Patent Application No. 2002-296268, filed on October 9, 2002, and U.S. Provisional Application No.60/483,635, filed on July 1, 2003, the disclosure of which are incorporated by reference in their entireties.

Cross Reference to Related Applications

This application is an application filed under 35 U.S.C. § 111(a) claiming the benefit pursuant to 35 U.S.C. § 119(e)(1) of the filing date of U.S. Provisional Application No.60/483,635, filed on July 1, 2003, pursuant to 35 U.S.C. § 111(b).

Technical Field

The present invention relates to an aluminum alloy for cutting processing containing no Pb, and also related to an aluminum alloy worked article made of the aforementioned aluminum alloy.

Background Art

In cutting processing of aluminum alloy materials, a step of disposing chips is required since continuous chips are generated during the cutting processing. Also required is a step of

eliminating burrs which generate at corner portions of an article during the turning processing or at a periphery of drilled holes during the drill processing. Under the circumstances, it has been required to provide an aluminum alloy excellent in cutting processability and in breaking ability of chips which is capable of reducing generation of burrs.

In order to enhance the cutting processability of an aluminum alloy, conventionally, it has been performed to add Pb which is a low-melting element to an aluminum alloy. One example of such an aluminum alloy containing Pb, which is excellent in cutting processability, is A2011 alloy (JIS (Japanese Industrial Standards) H4040). However, from the viewpoint of global environment protection, it is preferable to avoid manufacturing and using such an aluminum alloy containing Pb which is a harmful element. Considering the above, for example, an aluminum alloy in which the Pb content is controlled or an aluminum alloy to which Bi or Sn is added in place of Pb has been developed (see, e.g., JP H2-85331 A (claims 1 to 3), JP 2000-328168 A (claims 1 to 4) and JP 2001-240931 A (claims 1 to 4).

However, since enough cutting processability cannot be obtained by the aforementioned non-Pb-containing aluminum alloys, further improvement is expected. Furthermore, since cut aluminum alloy materials may sometimes be subjected to anodic oxide coating processing, it is also required to improve characteristics such as coating creation efficiency other than cutting processability

to quickly create a uniform anodic oxide coating.

Disclosure of Invention

In view of the aforementioned technical background, it is an object of the present invention to provide an aluminum alloy excellent in cutting processability containing no Pb and in coating processability, and also to provide an aluminum alloy worked article made of the aforementioned aluminum alloy.

In order to attain the aforementioned objects, the present invention has the following structural features.

(1) An aluminum alloy for cutting processing, the aluminum alloy consisting essentially of Cu: 1 to 6.5 mass%, Zn: 0.05 to 1 mass%, Bi: 0.1 to 1 mass%, Sn: 0.1 to 1 mass%, B: 100 mass ppm or less.

(2) The aluminum alloy for cutting processing as recited in the aforementioned Item (1), further including at least one element as a selective additional element selected from the group consisting of Fe: 0.05 to 1 mass%, Mg: 0.01 to 0.3 mass%, Si: 0.05 to 1 mass% and Ti: 0.01 to 0.5 mass%.

(3) The aluminum alloy for cutting processing as recited in the aforementioned Item (2), wherein the Mg content is 0.01 to 0.1 mass%.

(4) The aluminum alloy for cutting processing as recited in any one of the aforementioned Items (1) to (3), wherein the Cu content is 4 to 6 mass%.

(5) The aluminum alloy for cutting processing as recited in any one of the aforementioned Items (1) to (4), wherein the Zn content is 0.1 to 0.5 mass%.

(6) The aluminum alloy for cutting processing as recited in any one of the aforementioned Items (1) to (5), wherein the Bi content is 0.2 to 0.8 mass%.

(7) The aluminum alloy for cutting processing as recited in any one of the aforementioned Items (1) to (6), wherein the Sn content is 0.2 to 0.8 mass%.

(8) The aluminum alloy for cutting processing as recited in any one of the aforementioned Items (1) to (7), wherein the B content is 3 to 10 mass%.

(9) An aluminum alloy worked article made of the aluminum alloy for cutting processing as recited in any one of the aforementioned Items (1) to (8).

(10) The aluminum alloy worked article as recited in the aforementioned Item (9), wherein the aluminum alloy worked article is an extruded article.

(11) The aluminum alloy worked article as recited in the aforementioned Item (9), wherein the aluminum alloy worked article is a cut article made by cutting a raw material.

(12) The aluminum alloy worked article as recited in any one of the aforementioned Items (9) to (11), wherein the aluminum alloy worked article has an anodic oxide coating formed on a surface thereof.

According to the aluminum alloy for cutting processing as recited in the aforementioned Item (1), excellent cutting processability, mechanical characteristics and coating processability can be obtained without adding Pb. Furthermore, the aluminum alloy causes less abrasion and/or damage on a cutting tool.

According to the aluminum alloy for cutting processing as recited in the aforementioned Item (2), further enhanced cutting processability can be obtained, and no special step for decreasing the amount of inevitably contained Fe is required.

According to the aluminum alloy for cutting processing as recited in the aforementioned Item (3), extremely excellent strength and cutting processability can be obtained.

According to the aluminum alloy for cutting processing as recited in the aforementioned Item (4), extremely excellent cutting processability and mechanical characteristics can be obtained.

According to the aluminum alloy for cutting processing as recited in the aforementioned Item (5), extremely excellent cutting processability, mechanical characteristics and coating processability can be obtained.

According to the aluminum alloy for cutting processing as recited in the aforementioned Item (6), extremely excellent cutting processability can be obtained.

According to the aluminum alloy for cutting processing as recited in the aforementioned Item (7), extremely excellent cutting

processability can be obtained.

According to the aluminum alloy for cutting processing as recited in the aforementioned Item (8), extremely excellent cutting processability can be obtained.

According to the aluminum alloy worked article as recited in the aforementioned Item (9), since the article is made of the aluminum alloy for cutting processing as recited in any one of the aforementioned Items (1) to (8), the article is excellent in cutting processability, mechanical characteristics and coating processability.

According to the aluminum alloy worked article as recited in the aforementioned Item (10), the article is an extruded article excellent in cutting processability, mechanical characteristics and coating processability.

According to the aluminum alloy worked article as recited in the aforementioned Item (11), the article is excellent in surface quality because of the excellent cutting processability of the material.

According to the aluminum alloy worked article as recited in the aforementioned Item (12), the article is excellent in surface quality because of the uniformly formed anodic oxide coating.

Best Mode for Carrying Out the Invention

Hereinafter, the reasons for adding each element in the aluminum alloy for cutting processing according to the present

invention and the reasons for limiting the content thereof will be detailed.

In the compositions of the aluminum alloy for cutting processing, Cu, Zn, Bi, Sn and B are essential elements.

Cu is an element dissolved as solid dispersion in the aluminum mother phase and also dispersed in the aluminum mother phase as a deposited material such as $CuAl_2$ created by combining with Al, which improves the mechanical characteristics of the alloy and enhances the cutting processability. Furthermore, the synergistic effects with effects of another solid dispersion type elements further enhance the aforementioned effects. If the content of Cu is less than 1 mass%, the aforementioned effects become poor. To the contrary, if the content exceeds 6.5 mass%, there is a possibility that the corrosion resistance deteriorates. Accordingly, the Cu content should fall within the range of 1 to 6.5 mass%. The preferable Cu content is 4 to 6 mass%.

Zn is an element dissolved as solid dispersion in the aluminum mother phase and also dispersed in the aluminum mother phase as deposited material such as $MgZn_2$ created by combining with Mg, which improves the mechanical characteristics of the alloy and enhances the cutting processability. Furthermore, the synergistic effects with effects of another solid dispersion type elements further enhance the aforementioned effects. Furthermore, if the Zn content falls within the range specified by the present invention, the creation rate of an anodic oxide coating can be increased. As a

result, the aluminum alloy according to the present invention can be preferably used as a product to be subjected to anodizing for the purpose of improving the corrosion resistance, the ornamentation, etc. If the Zn content is less than 0.05 mass%, the aforementioned effects become poor. To the contrary, if the Zn content exceeds 1 mass%, the creation rate of an anodic oxide coating tends to be saturated. Accordingly, the Zn content should fall within the range of 0.05 to 1 mass%. The preferable Zn content is 0.1 to 0.5 mass%. More preferably, the content exceeds 0.2 mass% but not larger than 0.5 mass%.

Bi and Sn form a low melting Bi-Sn compound when Bi and Sn coexist, and the compound disperses in the alloy mother phase. The dispersed Bi-Sn compound is melted by heat generated during the cutting processing, resulting in fusion embrittlement of the chips, which enhances the chips breakability. The contents of these elements should fall within the range of Bi: 0.1 to 1 mass% and Sn: 0.1 to 1 mass%. If each content is less than the lower limit, the aforementioned effects become poor. To the contrary, if each content exceeds the upper limit, the casting characteristics deteriorate remarkably. The preferable Bi content and Sn content are Bi: 0.2 to 0.8 mass% and Sn: 0.2 to 0.8 mass%.

B has an effect of improving the cutting processability of the alloy by fining the casting structure to thereby form fine crystallized objects. The aforementioned effects can be obtained by adding a small amount of B. If the B content exceeds 100 mass

ppm, a tool life may deteriorate due to the abrasion or the breakage of the tool. Accordingly, the B content should be 100 mass ppm or less. The preferable B content is 3 to 10 mass ppm.

In the aforementioned aluminum alloy for cutting processing, for the purpose of further improving various characteristics of the alloy, any one or two or more of the elements selected from the group consisting of four (4) elements, Fe, Mg, Si and Ti, can be added to the basic compositions of the aluminum alloy containing the aforementioned five (5) essential elements.

Fe can disperse Si, which is effective in breakability of chips, as a single particle since a relatively small amount of Fe can be combined with Si when Fe coexists with Si, which enables excellent breakability of the chips. Furthermore, although Fe is an element inevitably contained in an aluminum alloy, if the Fe content falls within the range of 0.05 to 1 mass%, no special step for decreasing the Fe content is required since the content is an allowable amount for a normal manufacturing quality. An attempt to decrease the Fe content less than 0.05 mass% causes an increased cost. To the contrary, if the Fe content exceeds 1 mass%, a casting surface of a casting article such as a billet deteriorates, and the amount of the compounds with Si increases, causing decreased Si single particles, which in turn causes a deterioration of the breakability of chips. The preferable Fe amount is 0.05 to 0.5 mass%.

Mg is an element dissolved as solid dispersion in the alloy

mother phase and dispersed in the mother phase by combining with coexisting Cu or Si, which further improves the strength and the cutting processability of the aluminum alloy. If the Mg content is less than 0.01 mass%, the aforementioned effects become poor. To the contrary, if the Mg content exceeds 0.3 mass%, the hot-workability deteriorates. Accordingly, the Mg content should be 0.01 to 0.3 mass%. The preferable Mg content is 0.01 to 0.1 mass%.

Si, except for an amount required to form a compound, is dispersed in the alloy mother phase as single particles since only a small amount of Si is dissolved into an aluminum, which enhances the strength and the cutting processability of the aluminum alloy. Especially, Si forms Mg_2Si by the coexistence with Mg to increase the strength. Furthermore, dispersion of eutectic Si further enhances the aforementioned cutting processability improving effect. If the Si content is less than 0.05 mass%, the aforementioned effect becomes poor. To the contrary, if the Si content exceeds 1 mass%, although the cutting processability can be improved, abrasion or damage of a cutting tool becomes marked, resulting in a short tool life and deteriorated hot-workability. Accordingly, the Si content should be 0.05 to 1 mass%. The preferable Si content is 0.05 to 0.5 mass%.

Ti fines an ingot texture and forms fine crystallized objects by the recrystallization restrain effect, which improves the mechanical characteristics and the cutting processability of the aluminum alloy. Furthermore, Ti has an effect of improving the

corrosion resistance. If the Ti content is less than 0.01 mass%, the recrystallization depression effect deteriorates, causing, for example, an easy formation of rough recrystallization grains on a surface of an extruded article, which destabilizes the chips breakability in the cross-sectional direction. Furthermore, if the Ti content is less than 0.01 mass%, mechanical characteristics improving effect and corrosion resistance improving effect become poor. To the contrary, if the Ti content exceeds 0.5 mass%, there is a possibility that the casting workability of an extruding billet or the like deteriorates. Accordingly, the Ti content should fall within the range of 0.01 to 0.5 mass%. The preferable Ti content is 0.01 to 0.1 mass%.

If at least any one or plural elements to be arbitrarily selected from the aforementioned four (4) elements are added to the aforementioned essential five (5) elements, corresponding effects can be obtained.

The remaining compositions of the aluminum alloy for cutting processing according to the present invention are, for example, inevitable impurities and Al.

The aluminum alloy for cutting processing according to the present invention can be melted, cast into an ingot such as a slab or a billet, subjected to a surface cutting, soaking and then formed into a predetermined shape by plastic processing such as an extrusion or rolling by a common procedure. The heat treating, aging treating, washing, etc., in the aforementioned steps can also

be performed by a common procedure. The formed aluminum alloy material can be used widely as various products via cutting or anodizing processing as needed. The application examples include optical equipment parts such as lens frames, lens spacing tubes (camera cones), camera tripod fixing screws, office automation equipment parts or electronics device parts such as flanges for magnet rolls, square nuts for connectors or external screw tubes. The aforementioned optical device parts can be manufactured by, for example, extruding an aluminum alloy ingot into a bar-shaped extruded article or an annular-shaped extruded article, then cutting off these extruded articles and subjecting to cutting operation and thereafter subjecting to anodizing treatment.

The aluminum alloy worked article according to the present invention is an article obtained by forming the aforementioned aluminum alloy for cutting processing into a predetermined configuration, or further forming an anodic oxide coating thereon for the purpose of improving the corrosion resistance and ornamentation. As mentioned above, since the material alloy is excellent in mechanical characteristics, cutting processability and surface processing workability due to the chemical compositions, the aluminum alloy worked article can be preferably used as the aforementioned various applications.

The aluminum alloy worked article can be obtained by forming the material alloy by any method. Examples include a cut article formed by cutting an extruded article or a raw material and a rolled

article. The kind of material to be subjected to cutting processing is not limited to a specific one and can be any material such as an extruded material or a rolled material. At the time of cutting processing, generation of burrs can be suppressed, resulting in easy processing, which in turn results in a worked article with excellent surface quality.

In the aluminum alloy worked article, an anodic oxide coating can be formed on a surface by anodizing the worked article after the forming processing. Since the worked article is formed by material alloy excellent in coat processing workability, a uniform coating can be formed quickly. Thus, effects due to the coating formation such as an improvement of the corrosion resistance and/or the ornamentation can be obtained at the maximum, resulting in a worked article with excellent surface quality. The conditions of anodizing are not limited to specific ones, and any known method can be employed.

Examples

[Test A]

Aluminum alloys having compositions Nos. A1 to A30 shown in Table 1 were prepared. The alloy Nos. A1 to A21 according to the compositions of the present invention includes Cu, Zn, Bi, Sn, B and the balance being Al and impurities. The alloy Nos. A22 to A30 are comparative compositions.

The aluminum alloys Nos. A1 to A30 shown in Table 1 were used

as casting materials, and extruding billets each having a diameter of 200 mm were cast by a common procedure and then subjected to a homogenizing treatment. Thereafter, the billets were extruded into bars each having a diameter of 30 mm. Subsequently, these bars were subjected to a solution treatment for 5 hours at 495 ℃, and then subjected to water quenching. Then, these bars were drawn into 25 mm in diameter to thereby obtain T3 processed materials. Further, the obtained materials were subjected to artificial ageing processing for 14 hours at 130℃ to thereby obtain T8 processed materials. These T8 processed materials were used as test pieces.

On each obtained test piece, mechanical characteristics of 0.2% proof stress, tensile strength and elongation after fracture were measured, and cutting processability, abrasion of a tool, corrosion resistance and coating processability were examined according to the below-mentioned method. Then, these results were compared with characteristics of an extruded article of A2011 alloy (JIS (Japanese Industrial Standards) H4040) containing Pb and relatively evaluated by the following four grades.

◎: Excellent

○: Equivalent

△: Slightly inferior

×: Inferior

[Cutting processability]

Each test piece was subjected to wet cutting at cutting speed: 150m/min., feed rate: 0.2 mm/rev., cut depth: 1.0 mm. Then, the

breakability of chips is examined by the number of chips/100 g, and the cutting processability was evaluated by the breakability of chips.

[Abrasion of tool]

Each test piece was continuously subjected to dry cutting using high-speed steel single edge byte for five minutes under the conditions of cutting speed: 200 m/min., feed rate: 0.2 mm/rev., cut depth: 3 mm. Then, the abrasion width of the flank of the byte was measured.

[Corrosion resistance]

Neutral salt spray test based on JIS (Japanese Industrial Standards) Z2371 was performed, and the corrosion resistance of each test piece was evaluated by the mass loss by 1,000 hours spray.

[Coating processability]

Each piece was subjected to anodic oxidation coating processing by a common procedure, and the coating processability was evaluated by the thickness of the created anodic oxidation coating.

These results are also shown in Table 1.

Table 1

Alloy No. (An)		Chemical compositions(B: mass ppm, other: mass%, balance: Al)											Characteristics				
		Cu	Zn	Bi	Sn	B	Fe	Mg	Si	Ti	Pb	Impurities	Cutting processability	Corrosion resistance	Tool abrasion	Coating processability	Mechanical characteristics
Inventive compositions	1	1.0	0.2	0.8	0.5	10	-	-	-	-	-	≦0.05	○	◎	○	○	○
	2	4.0	0.2	0.8	0.5	10	-	-	-	-	-	≦0.05	○	○	○	○	○
	3	5.5	0.2	0.8	0.5	10	-	-	-	-	-	≦0.05	◎	○	○	○	○
	4	6.0	0.2	0.8	0.5	10	-	-	-	-	-	≦0.05	◎	○	○	○	○
	5	6.5	0.2	0.8	0.5	10	-	-	-	-	-	≦0.05	○	○	○	○	○
	6	5.5	0.1	0.8	0.5	10	-	-	-	-	-	≦0.05	◎	○	○	○	○
	7	5.5	0.3	0.8	0.5	10	-	-	-	-	-	≦0.05	◎	○	○	○	○
	8	5.5	0.4	0.8	0.5	10	-	-		-	-	≦0.05	◎	○	○	○	○
	9	5.5	0.5	0.8	0.5	10	-	-	-	-	-	≦0.05	◎	○	○	○	○
	10	5.5	0.2	0.1	0.5	10	-	-	-	-	-	≦0.05	○	○	○	○	○
	11	5.5	0.2	0.5	0.5	10	-	-	-	-	-	≦0.05	◎	○	○	○	○
	12	5.5	0.2	1.0	0.5	10	-	-	-	-	-	≦0.05	○	○	○	○	○
	13	5.5	0.2	0.8	0.1	10	-	-	-	-	-	≦0.05	○	○	○	○	○
	14	5.5	0.2	0.8	0.8	10	-	-	-	-	-	≦0.05	◎	○	○	○	○
	15	5.5	0.2	0.8	1.0	10	-	-	-	-	-	≦0.05	○	○	○	○	○
	16	5.5	0.2	0.8	0.5	3	-	-	-	-	-	≦0.05	◎	○	○	○	○
	17	5.5	0.2	0.8	0.5	5	-	-	-	-	-	≦0.05	◎	○	○	○	○
	18	5.5	0.2	0.8	0.5	20	-	-	-	-	-	≦0.05	◎	○	○	○	○
	19	4.5	0.3	0.5	0.8	6	-	-	-	-	-	≦0.05	◎	○	○	○	○
	20	5.5	0.2	0.2	0.5	10	-	-	-	-	-	≦0.05	◎	○	○	○	○
	21	5.5	0.2	0.8	0.2	10	-	-	-	-	-	≦0.05	◎	○	○	○	○
Comparative compositions	22	0.8	0.2	0.8	0.5	10	-	-	-	-	-	≦0.05	×	◎	○	○	×
	23	7.0	0.2	0.8	0.5	10	-	-	-	-	-	≦0.05	○	×	△	△	○
	24	5.5	0.03	0.8	0.5	10	-	-	-	-	-	≦0.05	◎	○	○	○	△
	25	5.5	1.1	0.8	0.5	10	-	-	-	-	-	≦0.05	○	△	○	○	○
	26	5.5	0.2	0.08	0.5	10	-	-	-	-	-	≦0.05	×	○	○	○	△
	27	5.5	0.2	1.1	0.5	10	-	-	-	-	-	≦0.05	○	△	○	○	○
	28	5.5	0.2	0.8	0.08	10	-	-	-	-	-	≦0.05	×	○	○	○	△
	29	5.5	0.2	0.8	1.1	10	-	-	-	-	-	≦0.05	○	△	○	△	○
	30	0.8	0.2	0.8	0.5	110	-	-	-	-	-	≦0.05	○	○	×	△	○
A2011		5.5	-	0.6	-	10	0.2	-	0.15	0.02	0.6	≦0.05	○	○	○	○	○

From the results shown in Table 1, it has been confirmed that (1) the aluminum alloy for cutting processing according to the present invention has excellent cutting processability and mechanical strength equivalent to or superior to A2011 alloy without adding Pb, (2) abrasion of a tool due to cutting processing can be suppressed, and (3) the aluminum alloy has excellent corrosion resistance and anodic oxidation coating processability.

[Test B]

Aluminum alloys having compositions Nos. B1 to B26 shown in Table 2 were prepared. In the alloy Nos. B1 to B11, four optional elements (Fe, Mg, Si, Ti) are added to the basic compositions of alloy No. A3. In the alloy Nos. B12 to B22, four optional elements are added to the basic compositions of alloy No. A19. The alloy Nos. B23 to B26 are comparative compositions.

These aluminum alloys were used as casting materials, and test pieces were manufactured by the same method as the aforementioned test A. Then, on each test piece, mechanical characteristics, cutting processability, abrasion of a tool, corrosion resistance and coating processability were examined in the same method as Test A. Then, the results of the alloy Nos. B1 to B11, B23 to B26 were compared with the result of the alloy No. A3 as a comparative material, and the results of the alloy Nos. B12 to B22 were compared with the result of the alloy No. A19 as a comparative material. These relative evaluations are shown by the following four grades.

◎: Excellent

○: Equivalent

△: Slightly inferior

×: Inferior

These results are also shown in Table 2.

Table 2

Alloy No. (Bn)		Chemical compositions(B: mass ppm, other: mass%, balance: Al)										Characteristics					
		Cu	Zn	Bi	Sn	B	Fe	Mg	Si	Ti	Impurities	Cutting processability	Corrosion resistance	Tool abrasion	Coating processability	Mechanical characteristics	Etc
Inventive compositions	1	5.5	0.2	0.8	0.5	10	0.2	-	-	-	≦0.05	◎	○	○	○	○	No cost up
	2	5.5	0.2	0.8	0.5	10	0.5	-	-	-	≦0.05	◎	○	○	○	○	
	3	5.5	0.2	0.8	0.5	10	-	0.05	-	-	≦0.05	◎	○	○	○	◎	
	4	5.5	0.2	0.8	0.5	10	-	0.3	-	-	≦0.05	◎	○	○	○	◎	
	5	5.5	0.2	0.8	0.5	10	-	-	0.10	-	≦0.05	◎	○	○	○	◎	
	6	5.5	0.2	0.8	0.5	10	-	-	0.5	-	≦0.05	◎	○	○	○	◎	
	7	5.5	0.2	0.8	0.5	10	-	-	-	0.02	≦0.05	◎	○	○	○	◎	
	8	5.5	0.2	0.8	0.5	10	-	-	-	0.1	≦0.05	◎	○	○	○	◎	
	9	5.5	0.2	0.8	0.5	10	0.2	-	0.15	-	≦0.05	◎	○	○	○	◎	
	10	5.5	0.2	0.8	0.5	10	-	0.05	0.15	-	≦0.05	◎	○	○	○	◎	
	11	5.5	0.2	0.8	0.5	10	0.2	0.05	0.15	0.02	≦0.05	◎	○	○	○	◎	
	12	4.5	0.3	0.5	0.8	6	0.1	-	-	-	≦0.05	◎	○	○	○	○	No cost up
	13	4.5	0.3	0.5	0.8	6	0.4	-	-	-	≦0.05	◎	○	○	○	○	
	14	4.5	0.3	0.5	0.8	6	-	0.1	-	-	≦0.05	◎	○	○	○	◎	
	15	4.5	0.3	0.5	0.8	6	-	0.2	-	-	≦0.05	◎	○	○	○	◎	
	16	4.5	0.3	0.5	0.8	6	-	-	0.2	-	≦0.05	◎	○	○	○	◎	
	17	4.5	0.3	0.5	0.8	6	-	-	0.4	-	≦0.05	◎	○	○	○	◎	
	18	4.5	0.3	0.5	0.8	6	-	-	-	0.04	≦0.05	◎	○	○	○	◎	
	19	4.5	0.3	0.5	0.8	6	-	-	-	0.2	≦0.05	◎	○	○	○	◎	
	20	4.5	0.3	0.5	0.8	6	0.3	-	0.3	-	≦0.05	◎	○	○	○	◎	
	21	4.5	0.3	0.5	0.8	6	-	0.1	0.2	-	≦0.05	◎	○	○	○	◎	
	22	4.5	0.3	0.5	0.8	6	0.2	0.2	0.2	0.02	≦0.05	◎	○	○	○	◎	
Comparative compositions	23	5.5	0.3	0.8	0.5	10	1.2	-	-	-	≦0.05	◎	△	○	△	○	Casting surface deteriorates
	24	5.5	0.3	0.8	0.5	10	-	0.4	-	-	≦0.05	◎	○	○	○	◎	Workability deteriorates
	25	5.5	0.3	0.8	0.5	10	-	-	1.2	-	≦0.05	◎	△	△	△	◎	Workability deteriorates
	26	5.5	0.3	0.8	0.5	10	-	-	-	0.6	≦0.05	◎	○	△	○	◎	Casting deteriorates

From the results shown in Table 2, it has been confirmed that cutting processability and mechanical characteristics can be further improved by adding Fe, Mg, Si, Ti to the basic compositions. Furthermore, according to the alloys Nos. B1, B2, B12 and B13, it has been confirmed that if the Fe content falls within the range as defined by the present invention an aluminum alloy for cutting processing can be obtained without no special step.

To the contrary, in the alloy No. B23, the casting surface quality of the cast billet was poor, and the quality of the extruded test piece was also poor. In the alloys Nos. B24 and B25, the workability at the time of extrusion was poor, causing great difficulty to form. In addition, in the alloy No. B25, the abrasion of the cutting tool was heavy. In the alloy No. B26, the casting workability f the billet was poor, causing great difficulty to cast a billet.

The terms and expressions which have been employed herein are used as terms of description and not of limitation, and there is no intent, in the use of such terms and expressions, of excluding any of the equivalents of the features shown and described or portions thereof, but it is recognized that various modifications are possible within the scope of the invention claimed.

Industrial Applicability

The aluminum alloy according to the present invention is excellent in cutting processability, mechanical characteristics

and coating processability, and therefore the aluminum alloy can be widely used as materials for various aluminum articles. Furthermore, since the aluminum alloy does not contain Pb, it is recommended to use it from the view point of environmental conservation.